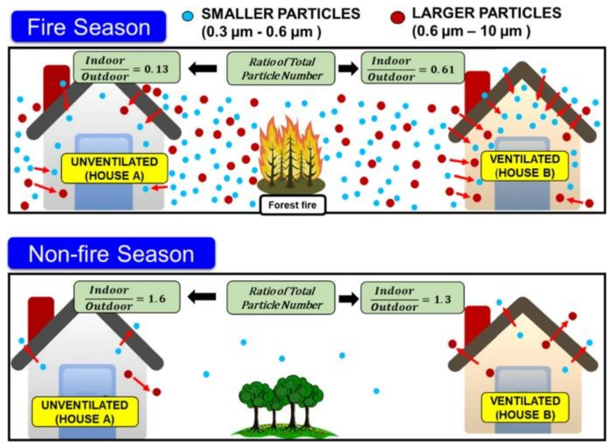
Select New Publications Recently Added to the Alaska Reference Database:
>>Spring 2022

FIRE EFFECTS ON HEALTH

- Outdoor and indoor concentrations of size-resolved particulate matter during a wildfire episode in interior Alaska and the impact of ventilation. *Dev, S., et al. 2021. Air Quality, Atmosphere & Health 114.* Indoor air concentrations of fine smoke particles are much lower (10x lower) inside buildings, as demonstrated by this study in three Fairbanks, AK buildings in 2015 and 2017. However, HVAC systems that provide active circulation and filtration must be high quality (higher than a MERV rating of 11). An unventilated building actually had even lower concentrations of PM than buildings with HVAC systems. Their figure says it all:



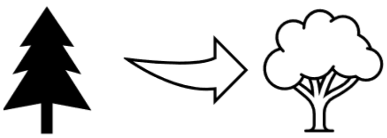
- Deterioration of lipid metabolism despite fitness improvements in wildland firefighters. *Dodds, P., et al. 2020. Medicine & Science in Sports & Exercise (Poster). 52. 364-364.* The research team (including Dr. Robert Coker of UAF) followed 100 firefighters from 7 hotshot crews over a season—looking at blood lipids and other indicators of cardiovascular health. Despite high physical exertion and activity, serum cholesterol, triglycerides, LDL and VLDL *increased* from pre- to post-season—contrary to expectations. (Note: concurrent non-allied research on runners is suggesting that exposure to air pollutants may offset the cardiovascular benefits of their exercise when they have high exposure levels. Hmm?)

CHANGING ENVIRONMENT

- Interior Alaska DoD training land wildlife habitat vulnerability to permafrost thaw, an altered fire regime, and hydrologic changes. *Douglas, T.A., et al. 2022. Engineer Research and Development Center/CRREL MP-22-2.* Climate change and intensification of disturbance regimes are increasing the vulnerability of interior Alaska Department of Defense (DoD) training ranges to widespread land cover and hydrologic changes. The objective of this three-year research effort was to provide land managers a science-based geospatial framework to assess wildlife habitat impacts and identify vulnerable wildlife species whose habitats and resources are likely to decline in response to the permafrost degradation, changing wildfire regimes, and hydrologic reorganization projected to 2100. We linked field measurements, data synthesis, repeat imagery analyses, remote sensing measurements, and model simulations focused on land cover dynamics and wildlife habitat characteristics into a framework designed to support decision making.

- Future increases in Arctic lightning and fire risk for permafrost carbon. *Chen, Y., Romps, D.M. et al. 2021. Nat. Clim. Chang.* ***11,*** *404–41.* Romps is famous for a 2014 paper in Science which predicted a 12% increase in lightning over the western continental US with every 1 deg C increase in summer temperature. In this paper Yang Chen teams up with him to look at high latitudes--including Alaska--and finds a similar—even stronger—relationship. By the last decades of the century, summer convective potential (or CAPE) is projected to increase 86% and precipitation 17%, which should cause lightning strikes to double. Thus, our grandkids will be seeing as much lightning at treeline/tundra areas as we do now in interior boreal forest.

-Lightning in the Arctic. Holzworth, R. et al. 2021. *Geophysical Research Letters, 48, e2020GL091366*. Using a relatively new World Wide Lightning Detection Network, the authors identified a trend with temperature in lightning strikes north of 65 deg N. Lighting in the arctic **tripled** as the global summer temperature anomaly increased 0.3 deg C over the relatively short 10 years their dataset allowed.



- Increasing fire and the decline of fire adapted black spruce in the boreal forest. *Baltzer, J. et al. 2021. PNAS: 118 (45) e2024872118.* With climate change and more frequent and severe fires, forest composition shifts away from black spruce dominance to broadleaf or (in Canada) pine species. There is ample evidence from a variety of studies that this is already beginning to occur, and Baltzer reported in 18% of over 1,500 field sites spruce regeneration failed after fire. Her bottom line: “While we find considerable remaining resilience in black spruce forests, predicted increases in climate moisture deficits and fire activity will erode this resilience, pushing the system toward a tipping point that has not been crossed in several thousand years.”

- An alternate vegetation type proves resilient and persists for decades following forest conversion in the North American boreal biome. *Hansen, W.D. et al., 2020. J Ecol. 109: 85– 98*. Conversion from black spruce to deciduous forest is already underway at regional scales in interior Alaska, and parts of Canada. Hansen, et al. show that this boreal deciduous forest type is likely a resilient alternate state that will persist through the 21st century, which is important, because forests of the future will shape biophysical feedbacks (burnability, surface albedo) to regional climate and disturbance regimes.

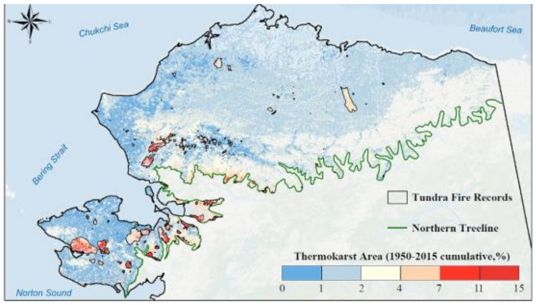
FIRE EFFECTS


Aggie Creek fire, Holly Krake

- Fire and Ice—The Effect of Wildfire on an Ice-Rich Slope along the Trans-Alaska Pipeline System. *Croft, Peppi et al. 2021. Geo-Extreme 2021 Conference Proceedings, 7-10 November 2021, Savannah, GA.* The 2015 Aggie Creek fire burned along roughly 8 miles of the Trans-Alaska Pipeline and fire crews used the pipeline corridor for burnouts in several sections. Alyeska knew the permafrost to be ice-rich and near the freeze-thaw temperature in certain areas, so Croft—an engineer, now with UAF--conducted a study in one such area (Globe Creek) over 5 years to follow the post-fire effects. Measurements showed substantial permafrost degradation and warming in the burned area and around the pipeline supports. The study concludes: “*the practice of using the TAPS ROW as a firebreak may need to be re-evaluated where TAPS traverses ice-rich permafrost*”.

- Coupled hydrological and geochemical impacts of wildfire in peatland-dominated regions of discontinuous permafrost. *Ackley, C. et al. 2021. Science of the Total Environment 782: 146841*. Large, severe tundra fires like the Anaktuvuk river fire have had large impacts on permafrost, surface topology and hydrology, but what about low-severity fires? The study focuses on a very small, low-severity wildfire in the Scotty Creek drainage—just across the border in NWT—in discontinuous permafrost. Detailed snow and hydrologic measure revealed lots of changes in the burned area, including accelerated snowmelt, earlier active layer thawing, and a tendency to decrease run-off and hold water in the top 20 cm of organic duff. Conclusion: even low-severity wildfires have the potential to trigger a series of complex, inter-related hydrological, thermal and biogeochemical processes and feedbacks.

- Thermokarst acceleration in Arctic tundra driven by climate change and fire disturbance. *Chen, Yaping et al. 2021. One Earth 4, 1–12.* Another important study led by Yaping showed that thermokarst rates



increased by 60% from 1950 to 2015 in Arctic Alaska, mainly driven by warmer and longer summers. However, wildfire is disproportionately responsible for 10.5% of all thermokarst formation, although only 3.4% of the landscape was reported burned (Fig. left). Fire effects on thawing can last for 80 years, and even low severity fires have effects. The study included field data from Uvgoon Ck (2012) and Sidik Lake (2010) tundra fires.

WILDLIFE AND FIRE

- Increasing fire frequency and severity will increase habitat loss for a boreal forest indicator species. *Palm, EC.; Suitor, MJ; Joly, K, Herriges, JD, et al. 2022. Ecological Applications. Accepted Manuscript e2549*. Now published, Eric's PhD research used caribou GPS collar data from multi-agencies in Alaska and Canada to document caribou movements in relation to fire disturbance. The data show that caribou avoid burned areas, especially in winter, less so in summer. There was a negative relationship between burn severity and lichen cover, confirming that caribou avoidance of burns was consistent with lower lichen abundance, so that increases in burning may lead to decreased habitat availability. Many caribou populations are declining. Conclusion: "Consistent winter avoidance of burns and severely burned areas suggest that caribou will experience increasing winter habitat loss as fire frequency and severity increase. . . .We suggest that management strategies prioritizing protection of core winter range habitat with lower burn probabilities would provide important climate-change refugia for caribou."

Macander et al. 2020. Lichen cover mapping for caribou ranges in interior Alaska and Yukon. Mapped lichen abundance on winter ranges of 9 caribou herds in Alaska and Yukon using a fusion of Landsat, aerial survey, drones and ground truthing (Random Forest model). They then used their lichen cover map to look at habitat preferences of the Fortymile Herd from 2012 to 2018. In both summer and winter, caribou avoided lichen-poor areas (0%–5% lichen cover) and showed stronger selection as lichen cover increased to ~30%. See also his ACCAP webinar on finding in plant functional types from 1985-2020: https://uaf-accap.org/event/march-2022-ecosystem-change-webinar/

FIRE REGIME

- Bottom-up drivers of future fire regimes in western boreal North America. *Foster, AC, et al. 2022. Environ. Res. Lett. 17 025006.* Authors used multiple ecological models, including the individual tree-growth model UVAFME, to test cumulative effect of fires and climate change on fuelbeds. Their models project extreme effects on fuelbeds (for example, Fairbanks moss duff would be as thin as Anchorage moss duff by the end of the century) and permafrost, and somewhat less pronounced effects on forest type conversion. Still, over 50% of interior boreal forest would be deciduous dominated by 2100. Linked models suggested the combination of more rainfall, less tree biomass and thinner & dryer fuelbeds might offset effects of more severe fire weather and fuel drying on wildfire intensity and combustion in the future.

- Ignition frequency and climate controlled Alaskan tundra fires during the Common Era. *Vachula, RS, et al. 2022. Quaternary Science Reviews 280, 107418*. Larger and more numerous fires in Alaskan tundra have been identified as harbingers of climate change but our period of fire records is relatively short. This study used Machine Learning methods to compare paleofire records with climate, vegetation, and other environmental datasets to determine which factors were the most important controls of tundra fire long-term. They identified atmospheric CO_2 as the primary control of tundra fire, followed by summer temperature, and precipitation. Vachula further suggests that atmospheric CO_2 directly increases lightning ignition frequencies while also promoting warm, dry fire weather conditions. He notes other recent studies also point to lightning as the dominant control of tundra fire occurrence. These findings are concerning given rapidly rising atmospheric CO_2 and climate projections.

CARBON

- Resilience and sensitivity of ecosystem carbon stocks to fire-regime change in Alaskan tundra. *Chen, Yaping; Kelly, R; Genet, H; Lara, MJ; Chipman, ML; McGuire, AD; and Feng Sheng Hu. 2022. Science of The Total Environment 806, Part 4:151482.* Here's a good reference source for Fire Return Interval of the piece of tundra you manage (currently ranging from 200 to 4400 years) based on paleofire records, as well as its Carbon (C) biomass content. Authors identify FRI tipping point (threshold) values for each region when carbon stock loss begins to accelerate. At that point, rapid thinning of the insulating organic layers coupled with abrupt deepening of active layers induces massive C release from the deep mineral soil horizons where most of it resides. Shrub tundra, with the highest fire fuel load, is the most sensitive—with a tipping point FRI around 1,000 years, where it begins to lose C more rapidly. As shrubification advances in tundra regions (“greening”) some have hypothesized that C storage will be enhanced but these authors think shifting stocks from soil to shrub will prime tundra landscapes for wildfires, discounting or even reversing benefits of more plant biomass.

- Disturbance suppresses the aboveground carbon sink in North American boreal forests. *Wang, JA et al. 2021. Nature Climate Change 11(5):435-441*. Jon Wang and team tackled the question of carbon balance in boreal forest using remote sensing methods to estimate above-ground biomass. From 1984 to 2014, they found fire disturbance was responsible for a loss of 789 Tg, while areas recovering from fires (going back to 1940) added about 642 Tg. So, the overall net loss in above-ground biomass from burned area his study was 147 Tg. Although some projections have indicated re-growth will offset C losses from future fire and preserve the C sink properties of boreal forests, Wang et al. shows that many large-scale models overestimate biomass accumulation by a factor of 3, even before considering large C losses from thinning soils or permafrost post-fire. These observations suggest that, at least for now, disturbed forests store less C and models probably overestimate the terrestrial carbon sink in boreal ecosystems. We need to improve the parameterization of fire in these models.

REVIEW ARTICLES:

York, Alison; Bhatt, Uma S.; Gargulinski, Emily; Grabinski, Zav; Jain, Piyush; Soja, Amber; Thoman, Rick L.; Ziel, Robert. 2021. Arctic report card 2020: wildland fire in high northern latitudes. Bulletin of the American Meteorological Society 102(8):11p.

Moore, Chris; Ziel, Robert. 2021. Fire Analysis in Alaska: A Quick Reference. Unpublished report. Alaska Wildland Fire Coordinating Group. 47 p.

Note: *Short overviews of articles by Randi Jandt—see the article links to review official abstracts.*

ALASKA FIRE SCIENCE CONSORTIUM